We started scans of new Hamamatsu 256 channel PMT

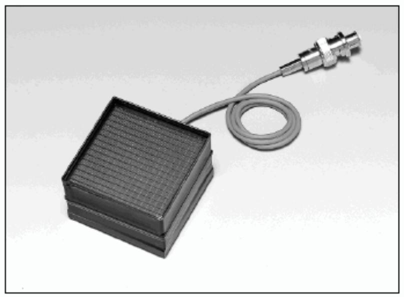
HAMAMATSU
PRELIMINARY DATA
APR. 2004

FLAT PANEL TYPE MULTIANODE PHOTOMULTIPLIER TUBE ASSEMBLY
H9500

52 mm Square, Bialkali Photocathode, 12-stage, 16 × 16 Multianode, Small Dead Space, Fast Time Response

APPLICATIONS

- Small Animal Imaging
- Compact Gamma Camera
- Scinti-mammography
- 2D Radiation Monitor
- Ring Image Cherenkov Counter



SPECIFICATIONS

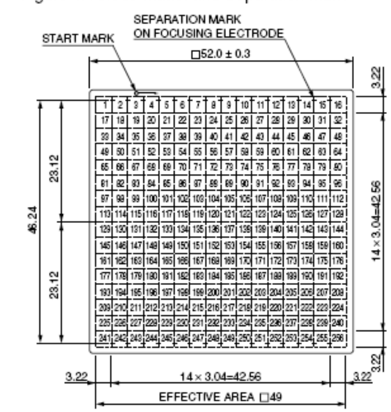
GENERAL

Parameter		Description	Unit
Spectral Response		300 to 650	nm
Peak Wavelength		420	nm
Photocathode Material		Bialkali	—
Window	Material	Borosilicate glass	—
	Thickness	1.5	mm
Dynode	Structure	Metal channel dynode	—
	Number of Stage	12	—
Number of Anode Pixels		256 (16 × 16 matrix)	—
Pixel Size / Pitch at Center		2.8 × 2.8 / 3.04	mm
Effective Area		49 × 49	mm
Dimensional Outline (W × H × D)		52 × 52 × 33.0	mm
Packing Density (Effective Area / External Size)		89	%
Weight		177	g
Operating Ambient Temperature		0 to +50	°C
Storage Temperature		-15 to +50	°C

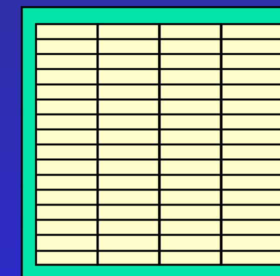
MAXIMUM RATINGS (Absolute Maximum Values)

Parameter	Value	Unit
Supply Voltage (Between Anode to Cathode)	-1100	V
Average Anode Output Current in Total	100	μA

Figure 4: Anode Matrix and Separation Mark



16*16 anode pads



4*16 channel readout

CHARACTERISTICS (at 25 °C)

Parameter		Min.	Typ.	Max.	Unit
Cathode Sensitivity	Luminous (A)	40	55	—	μA/lm
	Blue Sensitivity Index (CS 5-58) (B)	5.5	7.5	—	—
	Quantum Efficiency at 420 nm	—	19	—	%
Anode Sensitivity	Luminous (C)	—	55	—	A/lm
Gain (C)		0.1×10^6	1×10^6	—	—
Anode Dark Current per Channel (D)		—	0.1	—	nA
Anode Dark Current in Total (D)		—	26	100	nA
Time Response (E)	Rise Time (F)	—	0.8	—	ns
	Transit Time (G)	—	6	—	ns
	Transit Time Spread (FWHM) (H)	—	0.4	—	ns
Pulse Linearity per Channel (±2 % deviation)		—	0.2	—	mA
Uniformity (Condition Figure 3)		—	1: 5	1: 10	—
Cross-talk		—	5	—	%

Added four Phillips TDCs to the scanning setup. We can now measure precision timing (25ps/count) for 64 channels. (Using prototype CFDs.)

We are using the blue PiLas (430nm) for the scans.

PMT Uniformity

First scan with very fine grid (0.25mm*0.25mm scan); PMT at 900V

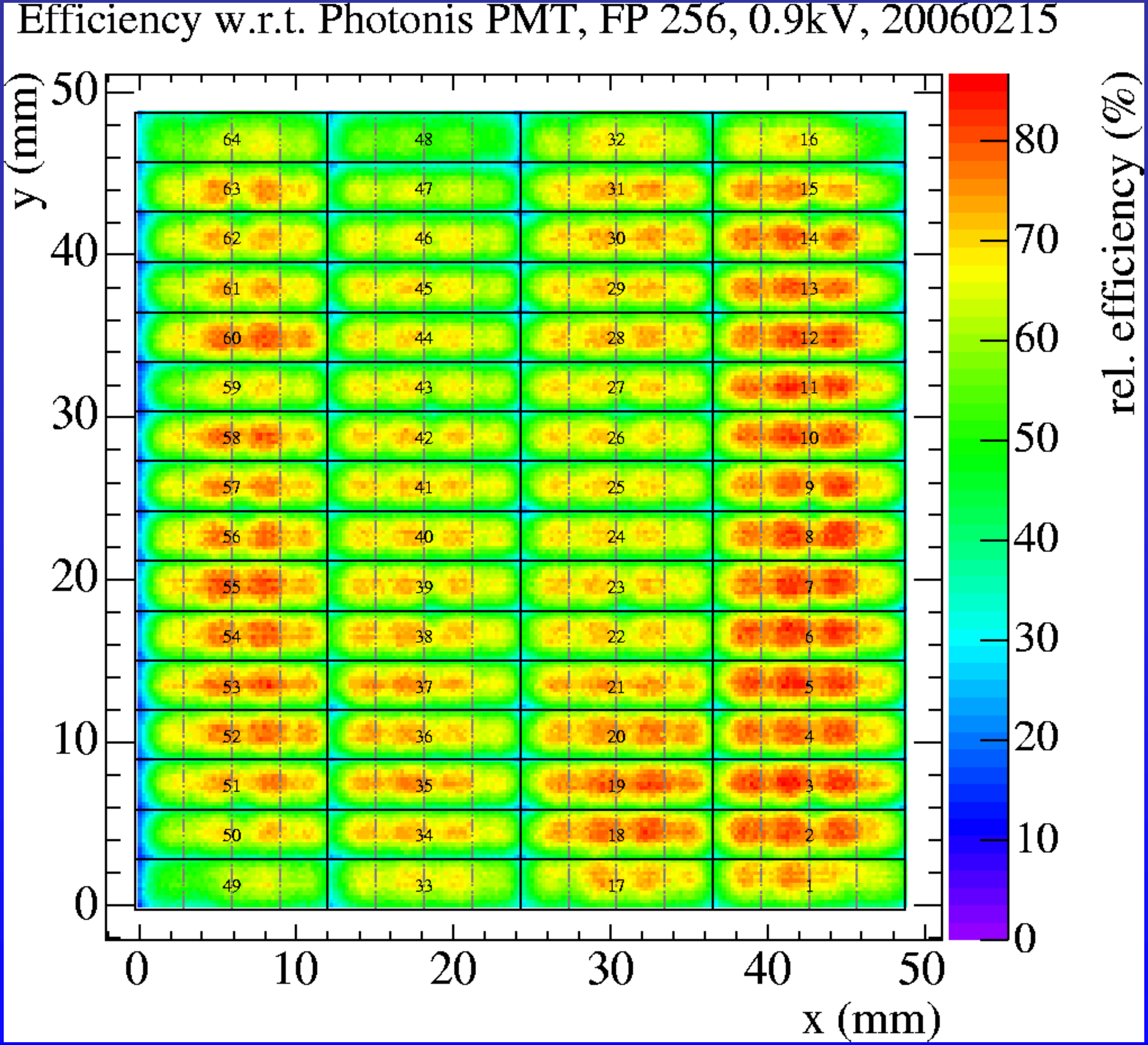
Very nice uniformity

Efficiency relative to Photonis

- values between 50% and 80%
- pad structure nicely visible

Scan performed with usual ESA Elantek amplifiers (130x)

(scan took 5 ½ days)



PMT Uniformity

hot off the press – results less than 3 hours old…

Second scan with fine grid (0.50mm*0.50mm scan); PMT at 1000V

For second scan used older amplifiers – lower gain (40 x) better match to Hamamatsu large pulses

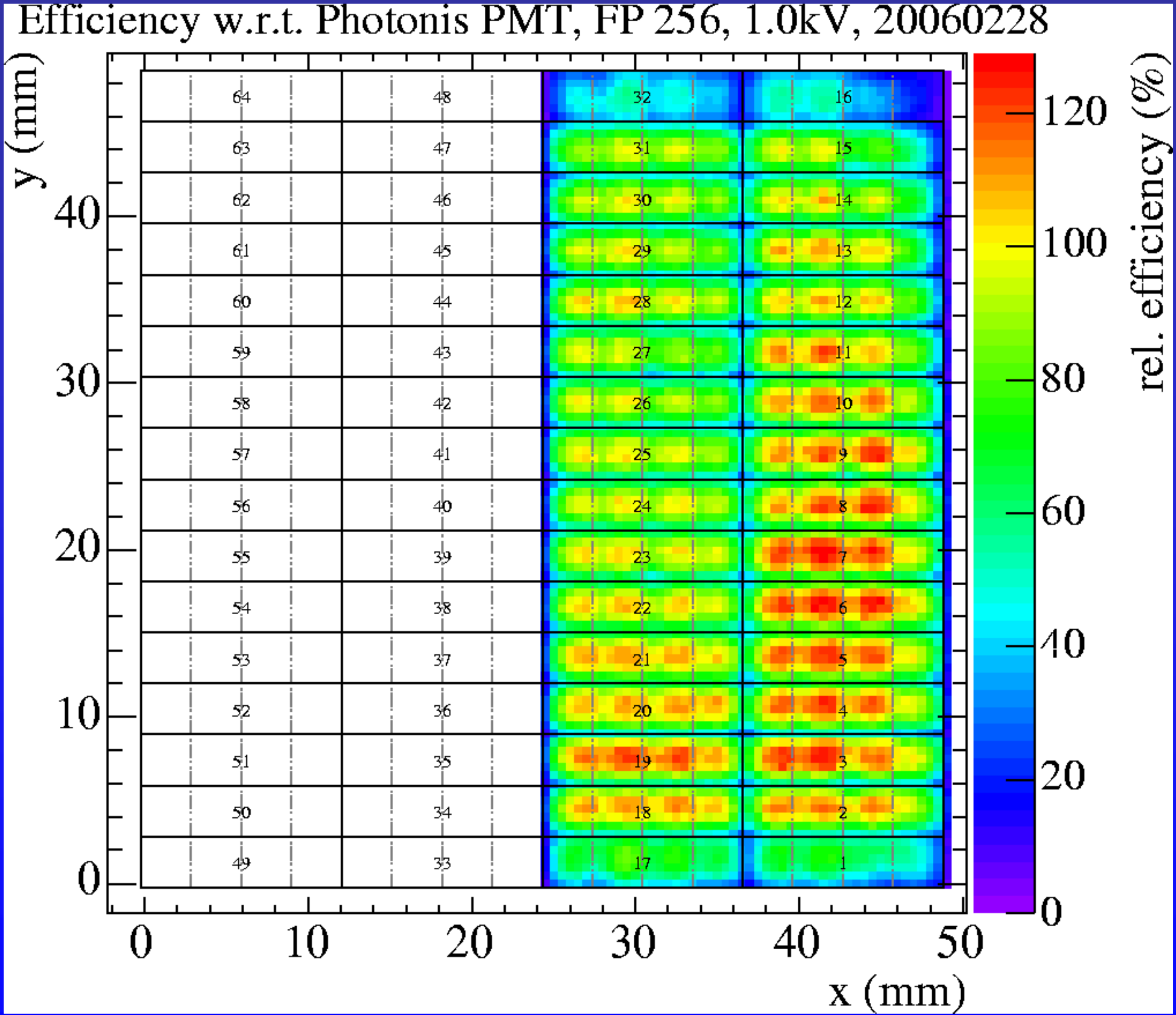
Read only channels 1-32 due do problem with amps.

With lower gain we can run higher voltage.

Efficiency relative to Photonis

values between 80% and 120%

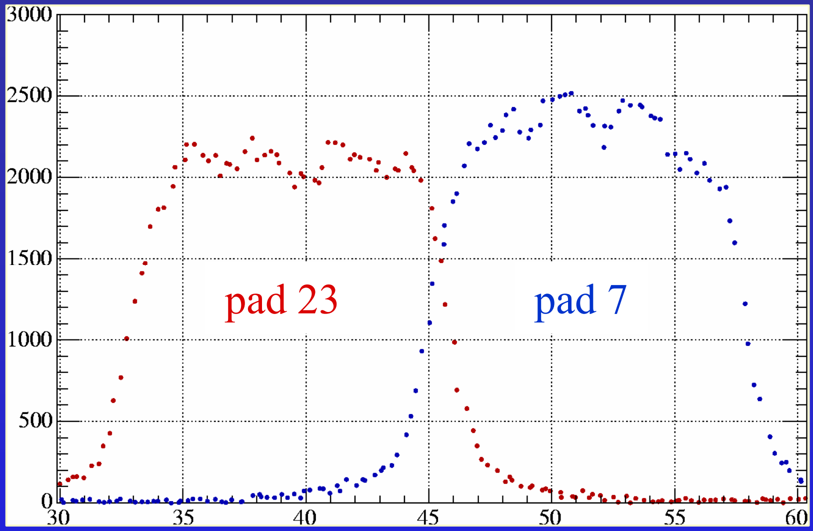
(scan took 1 ½ days)

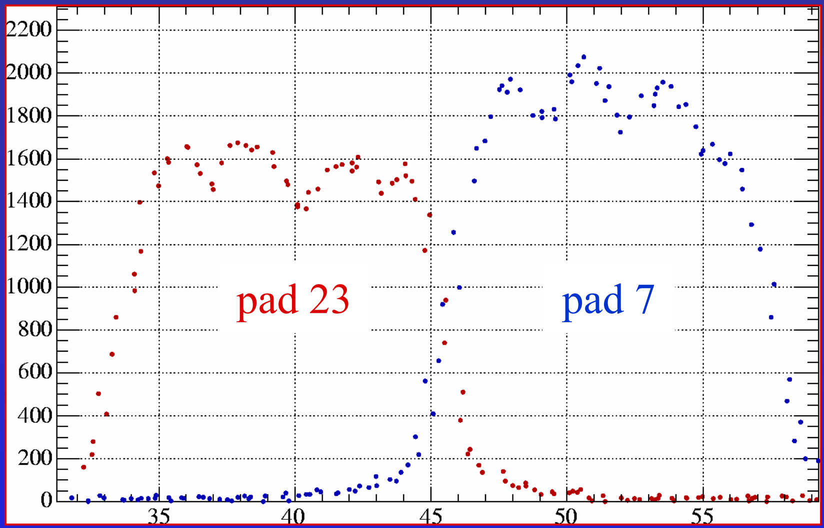


PMT Crosstalk/Charge Sharing

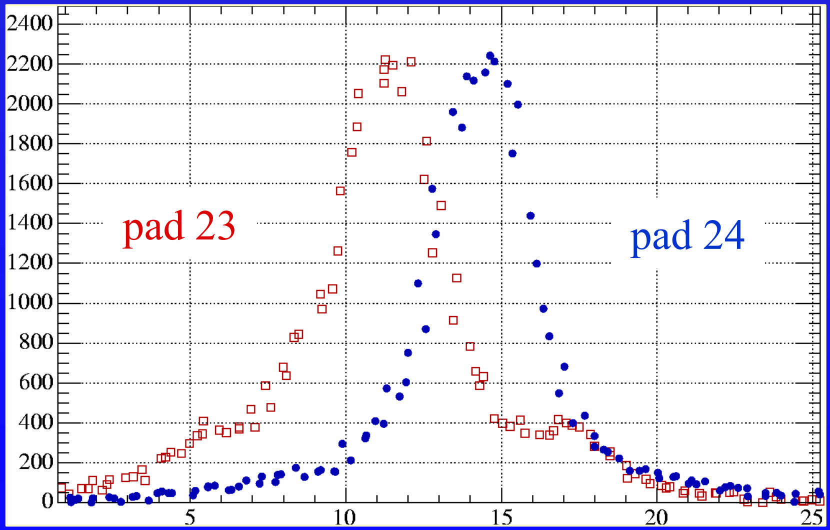
First scan: high-gain amps, 900V

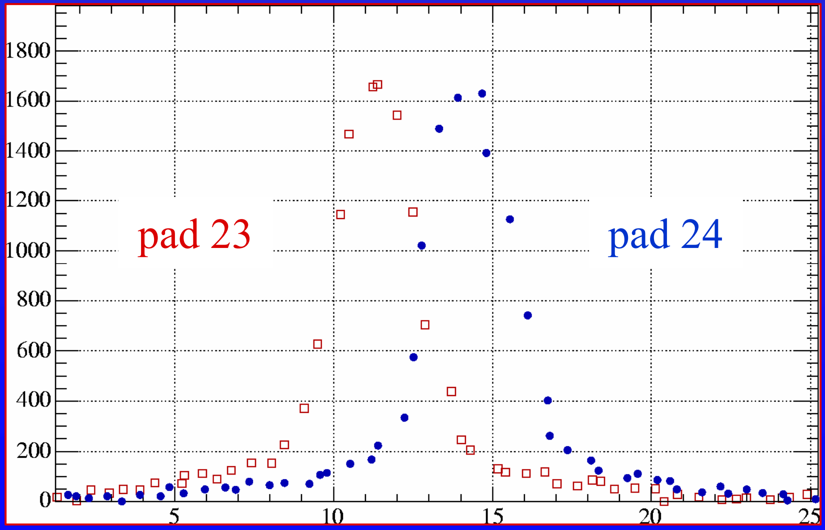
Second scan: 40x amps, 1000V





x (mm)





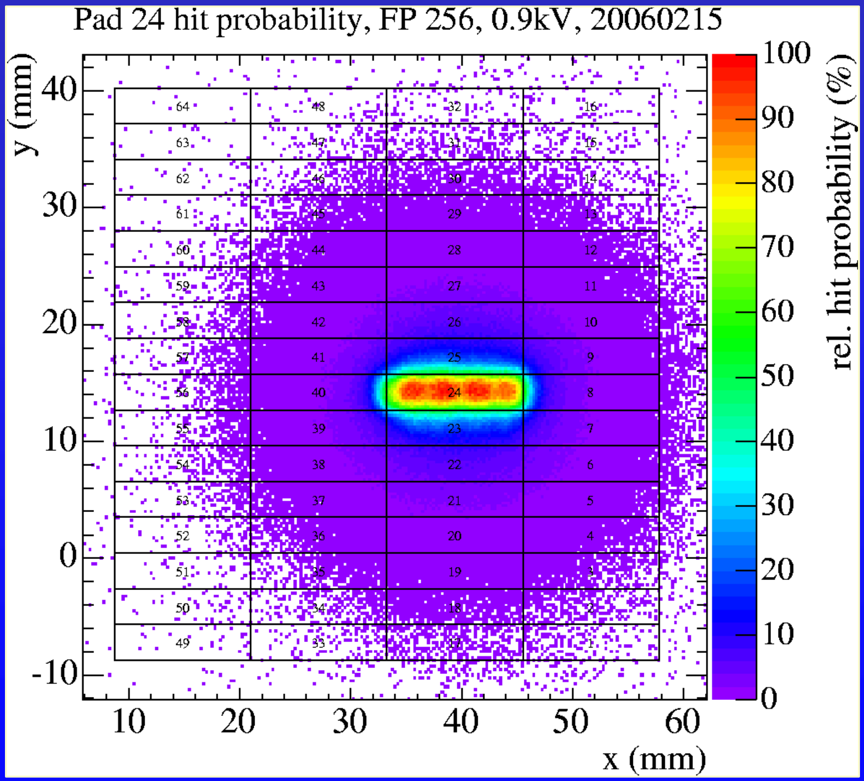
y (mm)

PMT Crosstalk/Charge Sharing

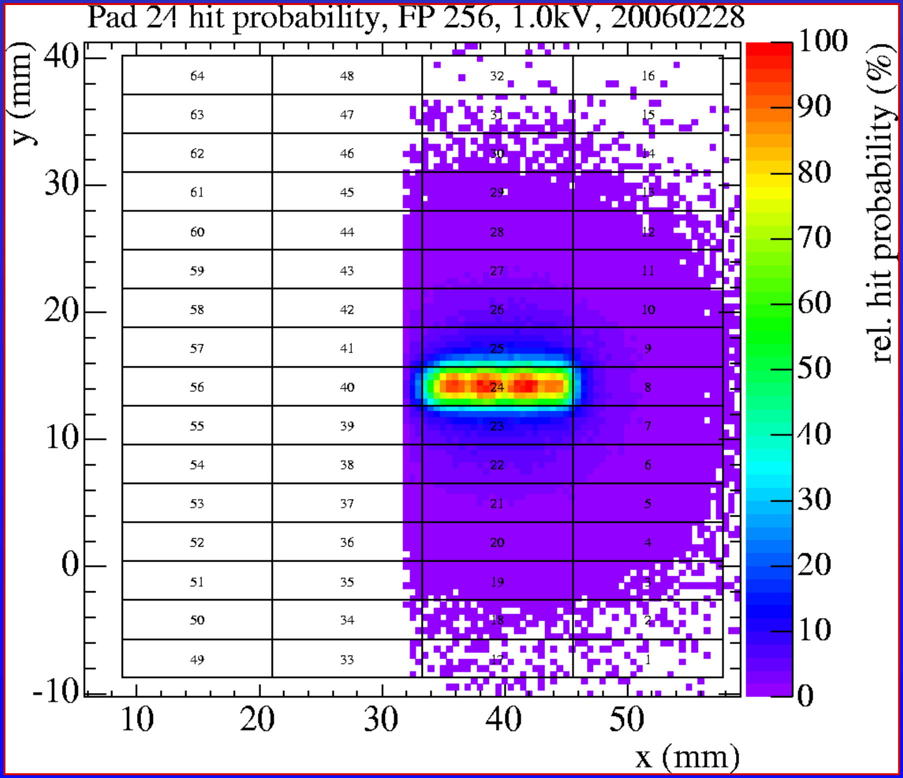
Collect laser locations that causes hit on pad 24.
Then plot hit probability on pad 24 relative to most probable spot.

Crosstalk/Charge Sharing slightly reduced with lower gain amps.

First scan: high-gain amps, 900V



Second scan: 40x amps, 1000V



PMT Crosstalk/Charge Sharing

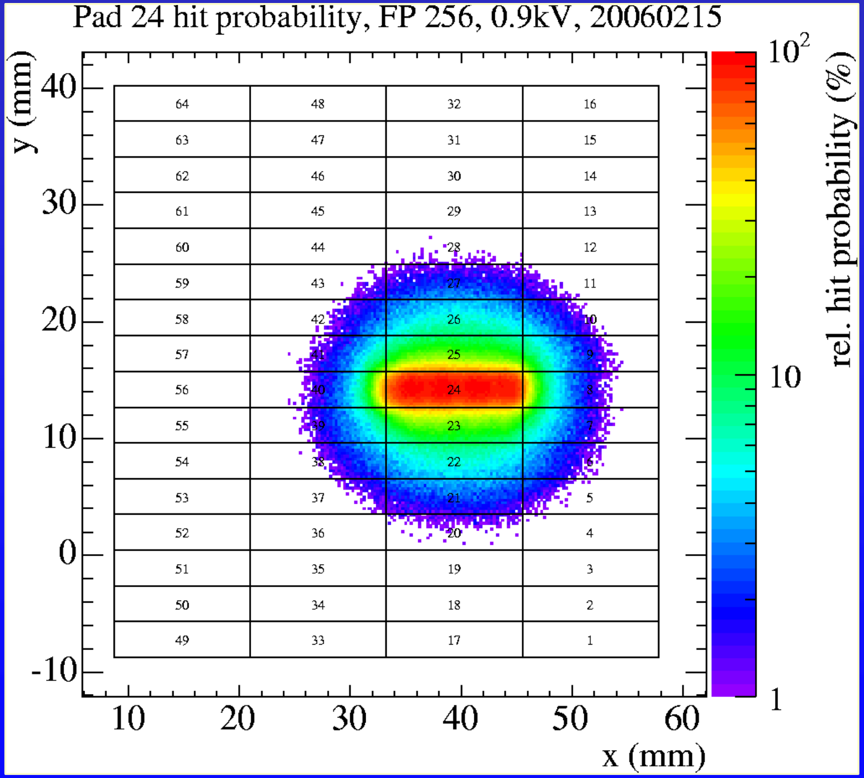
Collect laser locations that causes hit on pad 24.
Then plot hit probability on pad 24 relative to most probable spot.

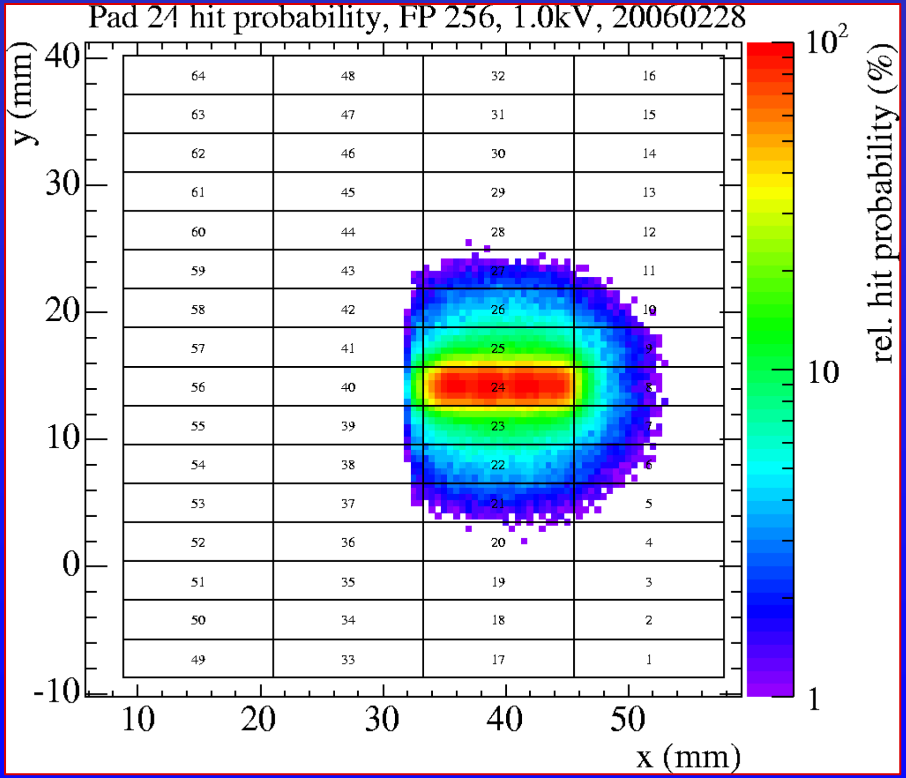
Crosstalk/Charge Sharing range slightly reduced with lower gain amps.

First scan: high-gain amps, 900V

log scale

Second scan: 40x amps, 1000V





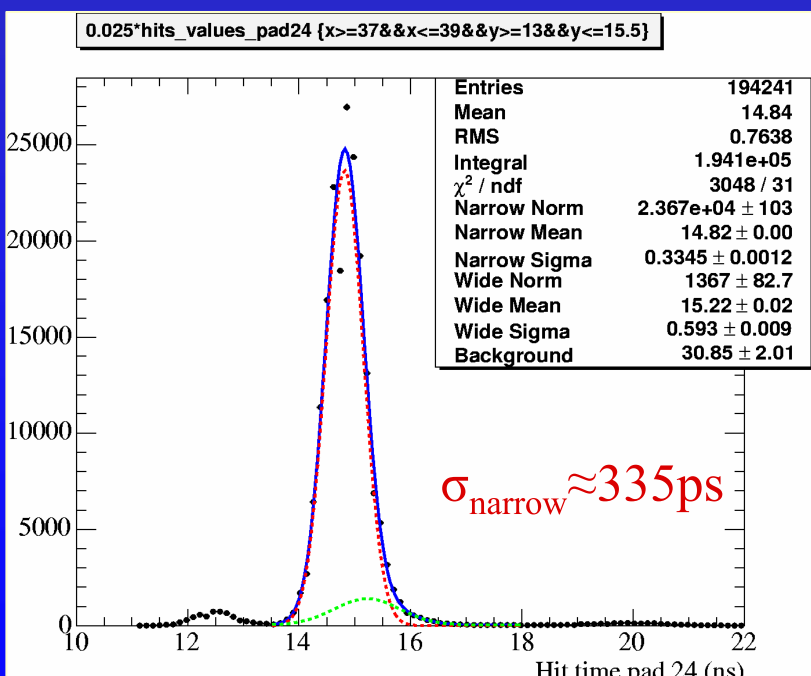
PMT Timing

Pick center of pad 24, fit with double-Gaussian plus constant

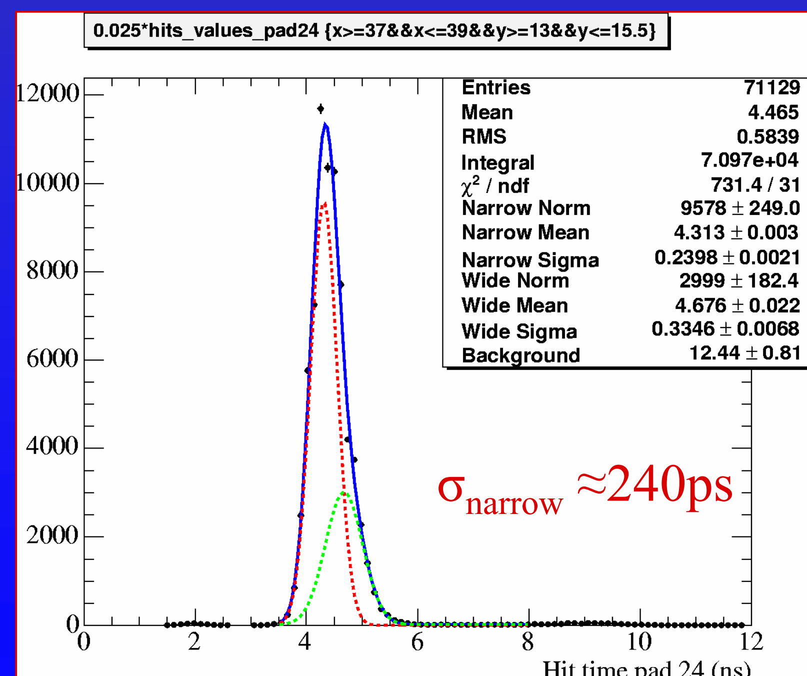
At higher voltage, lower gain the early time bump is gone.

At higher voltage, lower gain time resolution improves by ~30% to approx. 250ps

First scan: high-gain amps, 900V



Second scan: 40x amps, 1000V



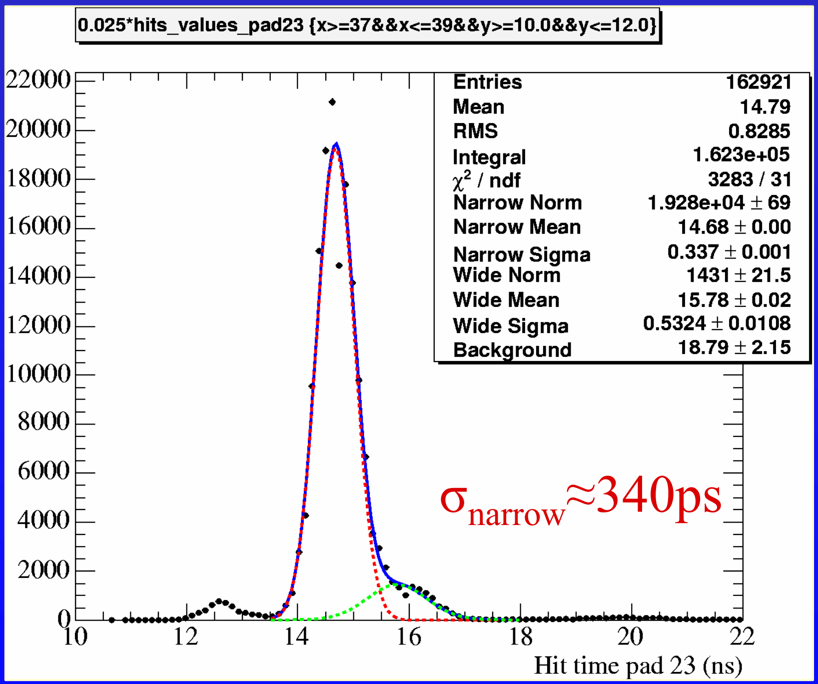
PMT Timing

Pick center of pad 23, fit with double-Gaussian plus constant

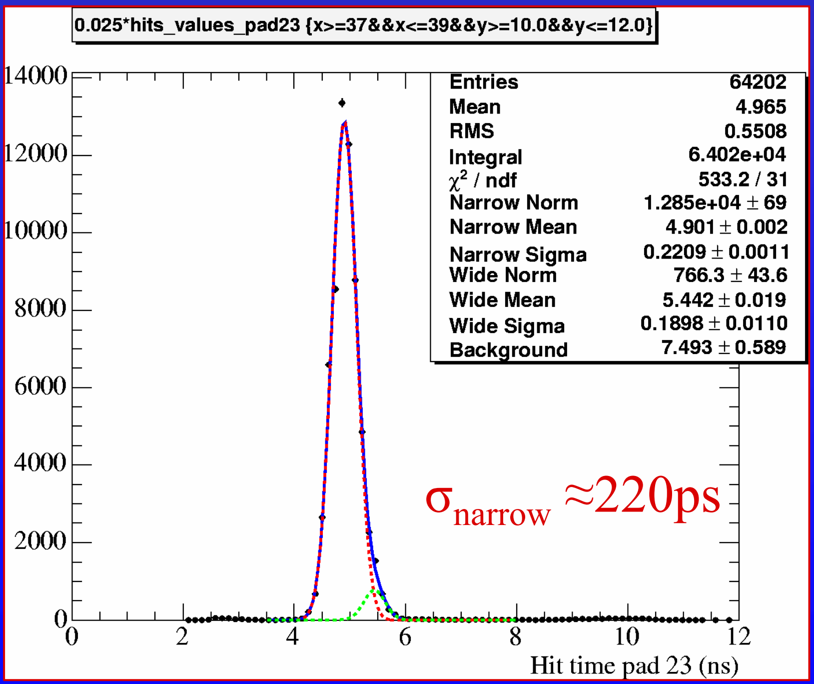
At higher voltage, lower gain the early and late time bumps are gone.

At higher voltage, lower gain time resolution improves by ~35% to approx. 220ps

First scan: high-gain amps, 900V



Second scan: 40x amps, 1000V

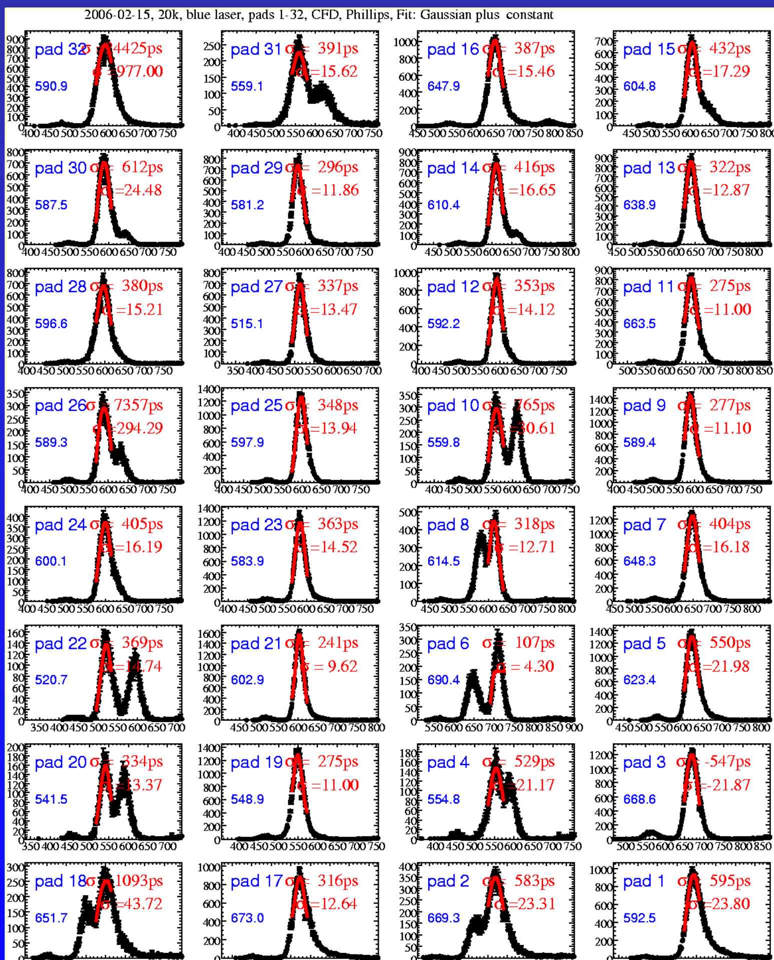


PMT Timing

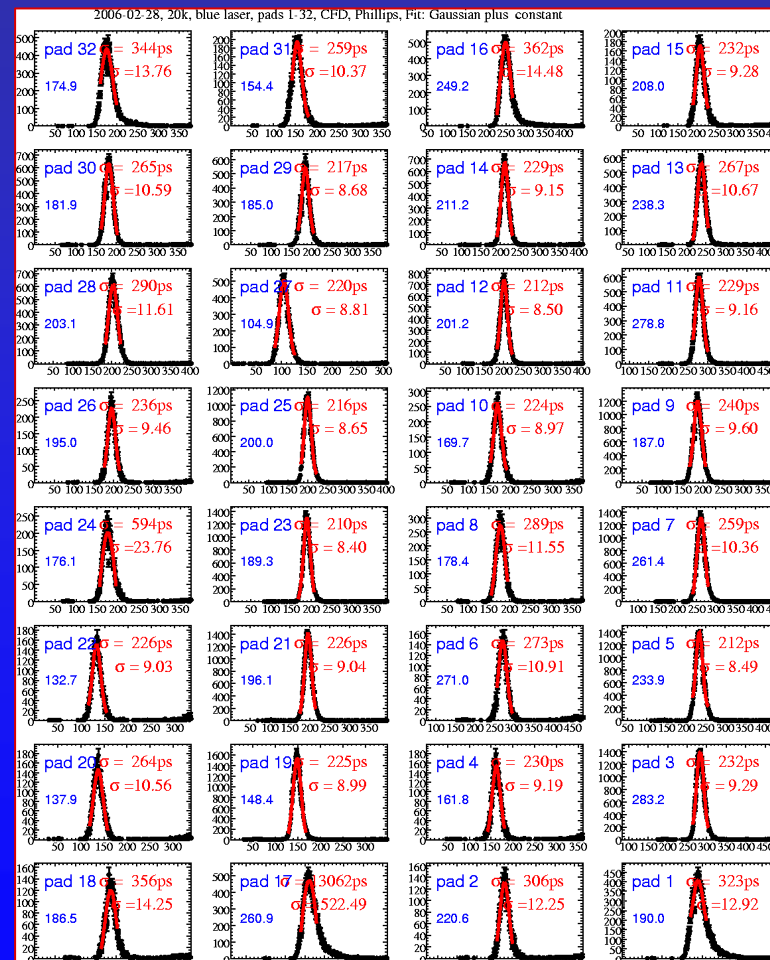
Pick center of pads, fit with single Gaussian plus constant

→ much improved timing at higher voltage, lower gain

First scan: high-gain amps, 900V



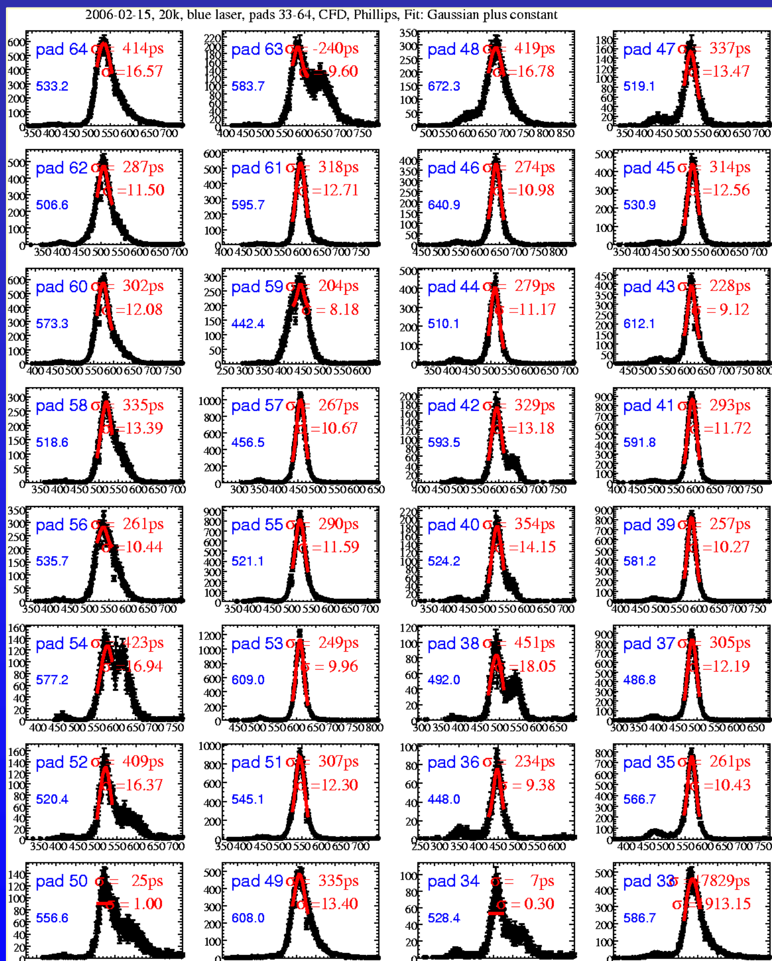
Second scan: 40x amps, 1000V



PMT Timing

Pick center of pads, fit with single Gaussian plus constant

First scan: high-gain amps, 900V



Overall initial impression:

new H9500 shows good uniformity (1:2)
over entire area

with appropriate amps the time resolution
at 1kV is 200-250ps for most channels

still need to study problematic channels,
extend scan to all 64 pads etc

(remember, 1kV scan results hot off the press)